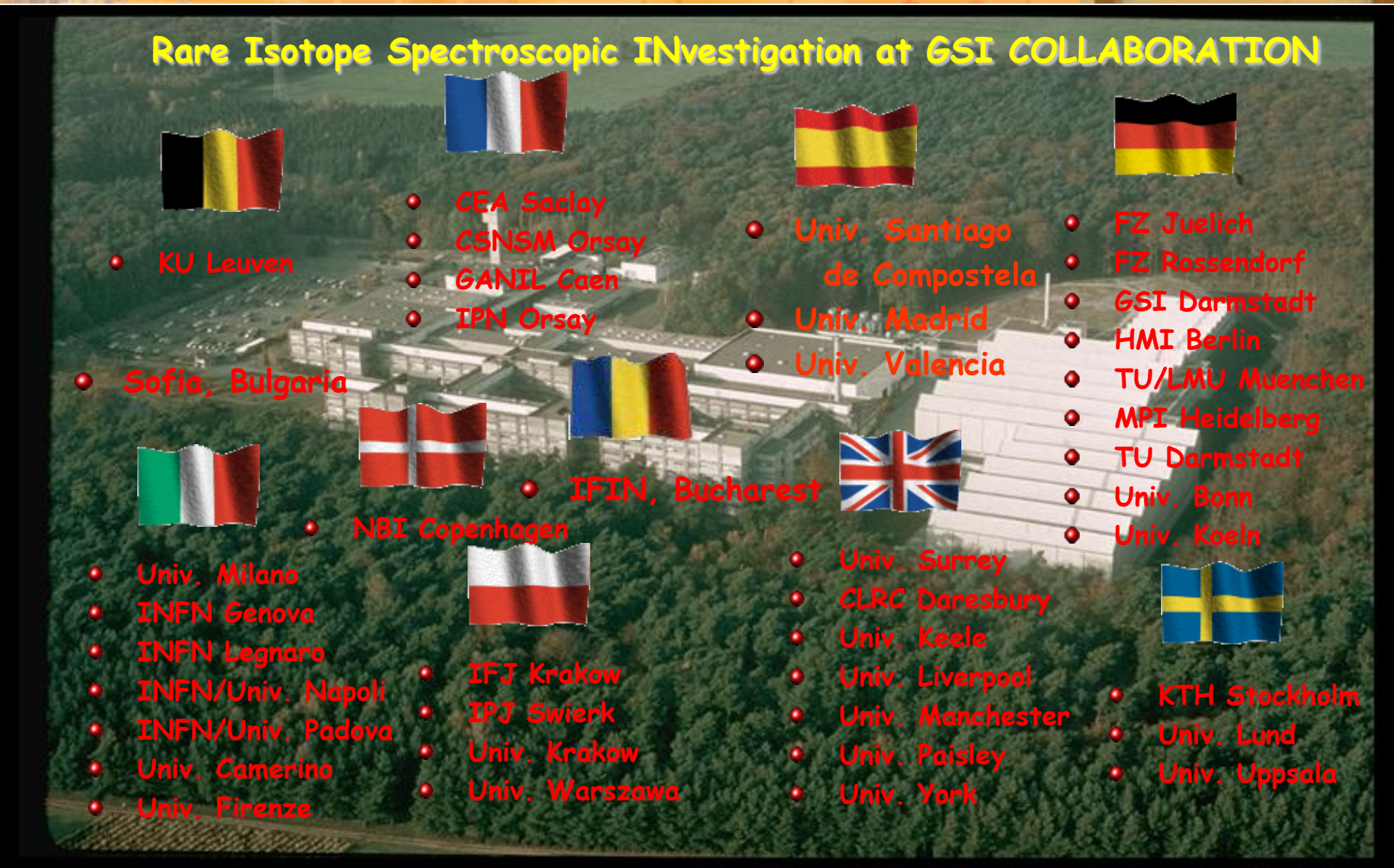
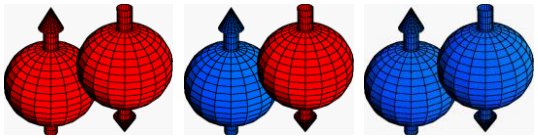
Recent results from RISING

M.Górska



RISING: Nuclear structure interest

Isospin competition/symmetry



$|T_z|=T=1$: $I^{\pi}=0^+$

$T=0$: $I^{\pi}=1^+$ or $(2j)^+$

Shell evolution/quenching

Experiments with Stopped Beams

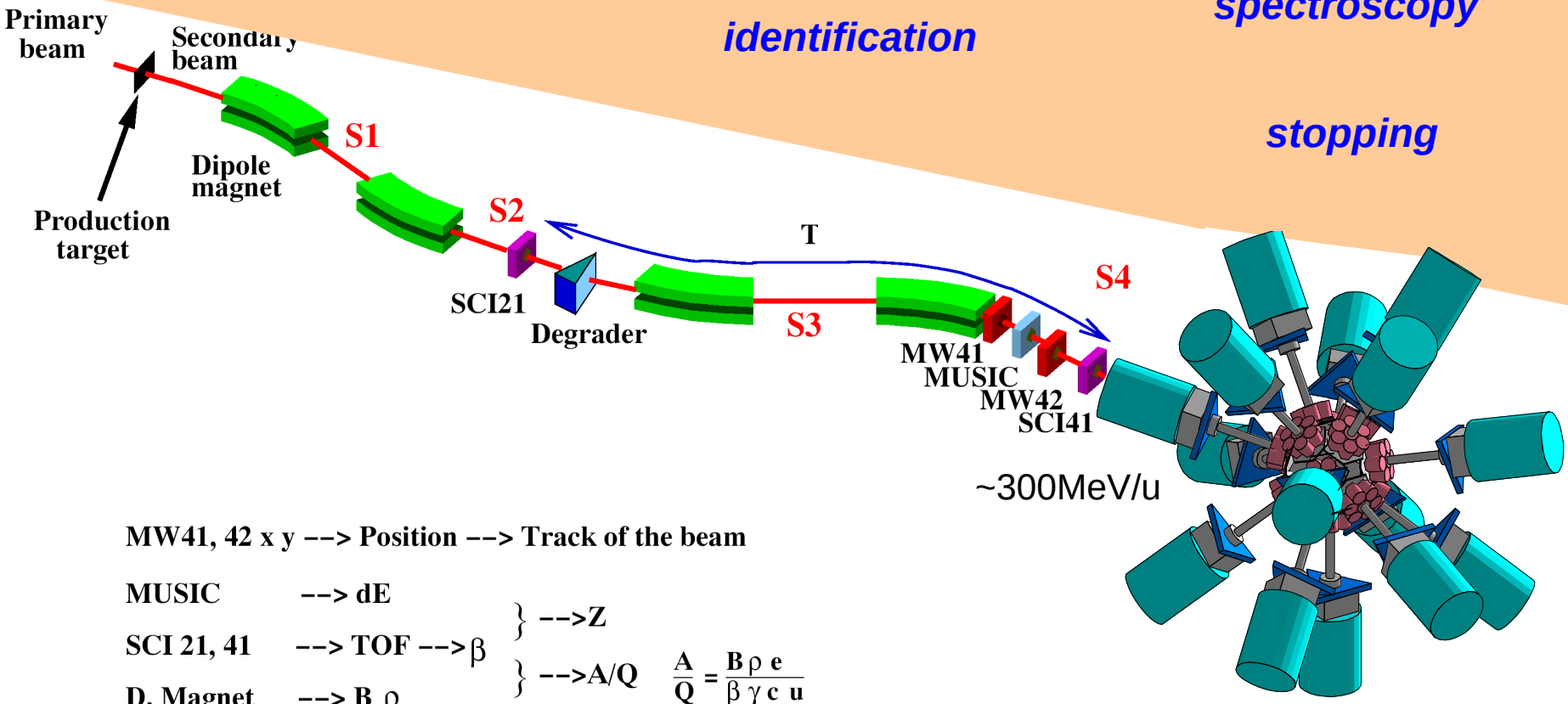
production

selection

identification

spectroscopy

stopping



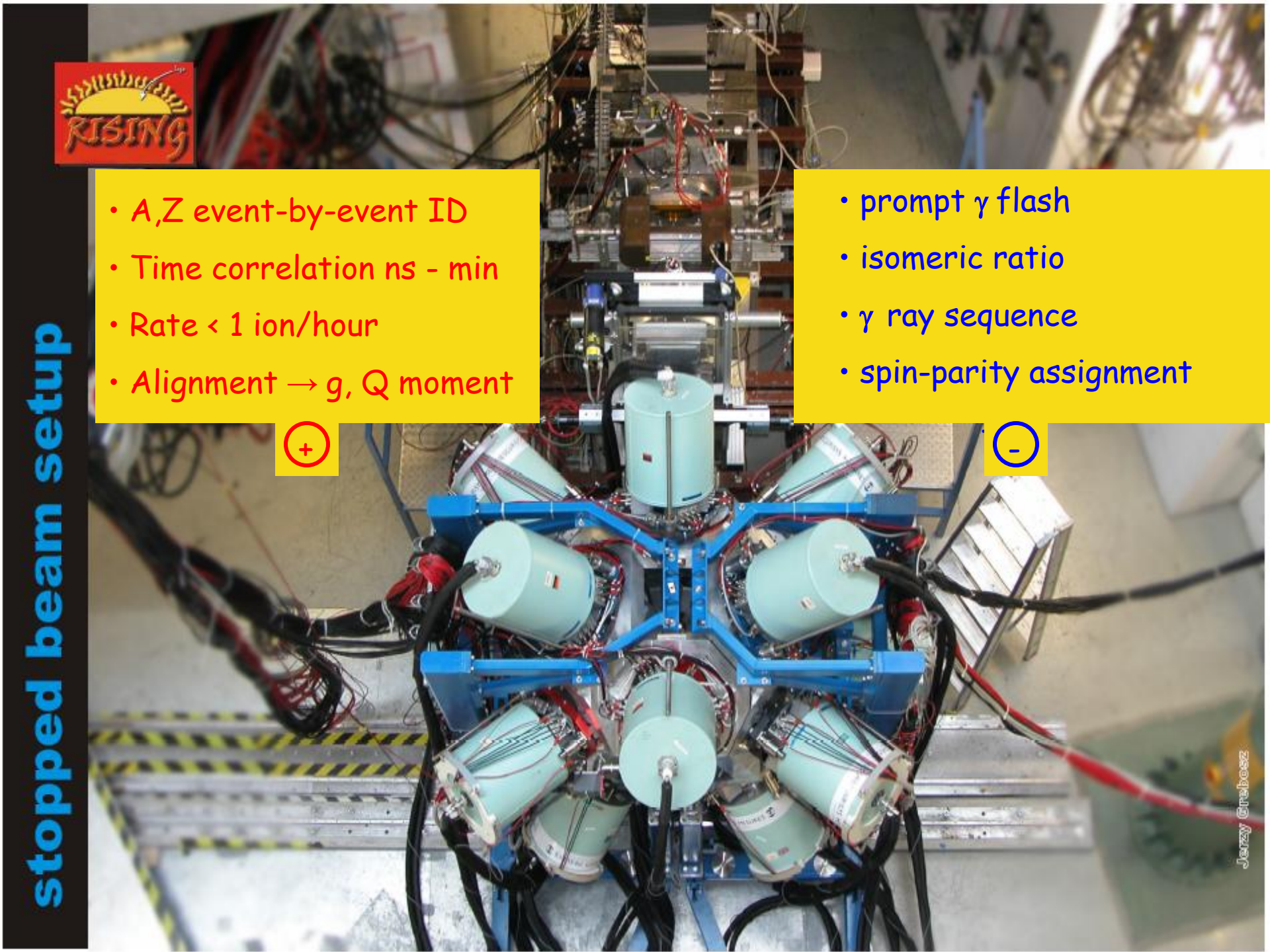
MW41, 42 x y --> Position --> Track of the beam

MUSIC --> dE

SCI 21, 41 --> TOF --> β } --> Z

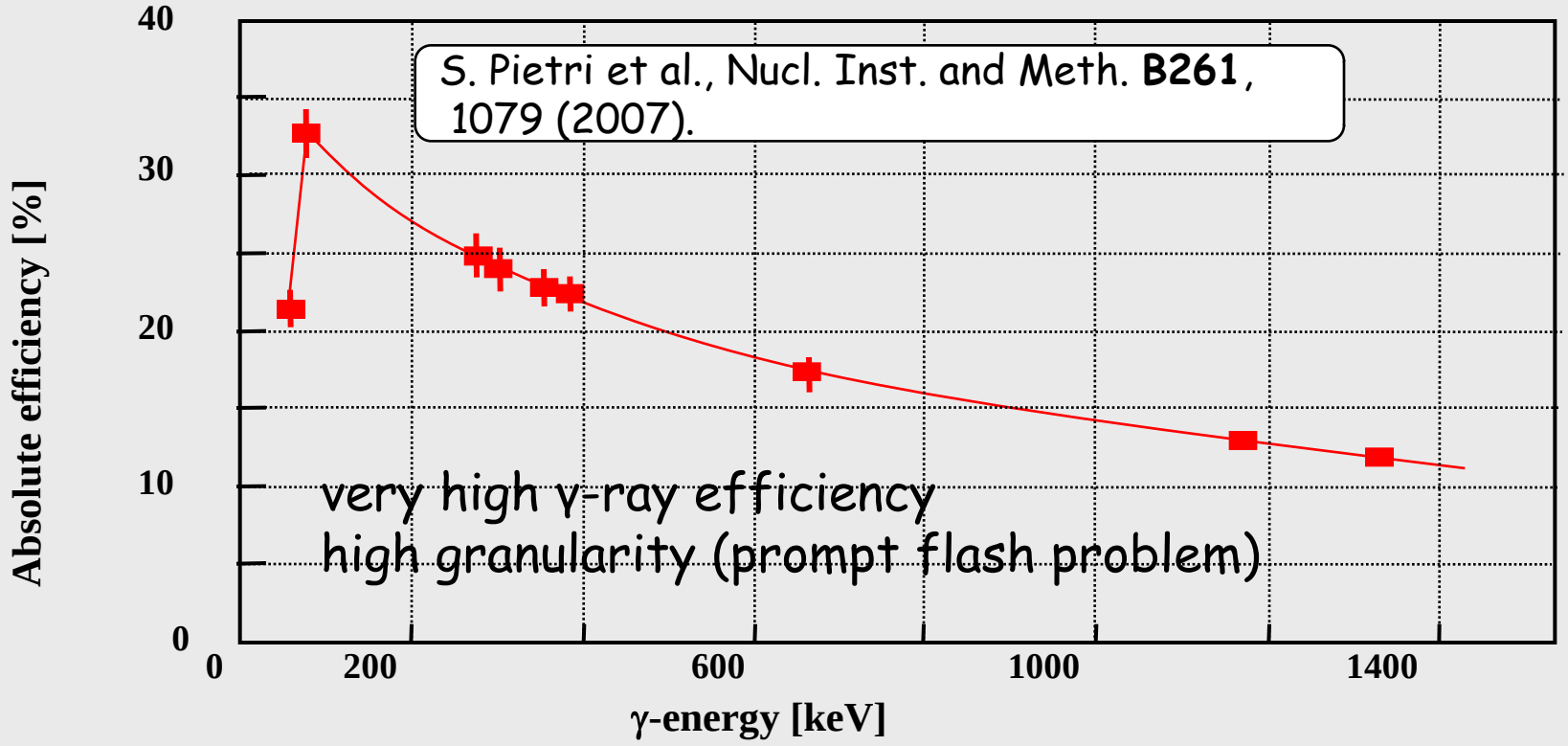
D. Magnet --> B ρ } --> A/Q

$$\frac{A}{Q} = \frac{B \rho e}{\beta \gamma c u}$$


stopped beam setup
RISING
• A,Z event-by-event ID
• Time correlation ns - min
• Rate < 1 ion/hour
• Alignment → g, Q moment
+
• prompt γ flash
• isomeric ratio
• γ ray sequence
• spin-parity assignment
-
Jerzy Grębosz

The RISING γ-ray spectrometer

- 15 EUROBALL Cluster (105 Ge crystals)
- digital signal processing via 30 XIA DGF modules

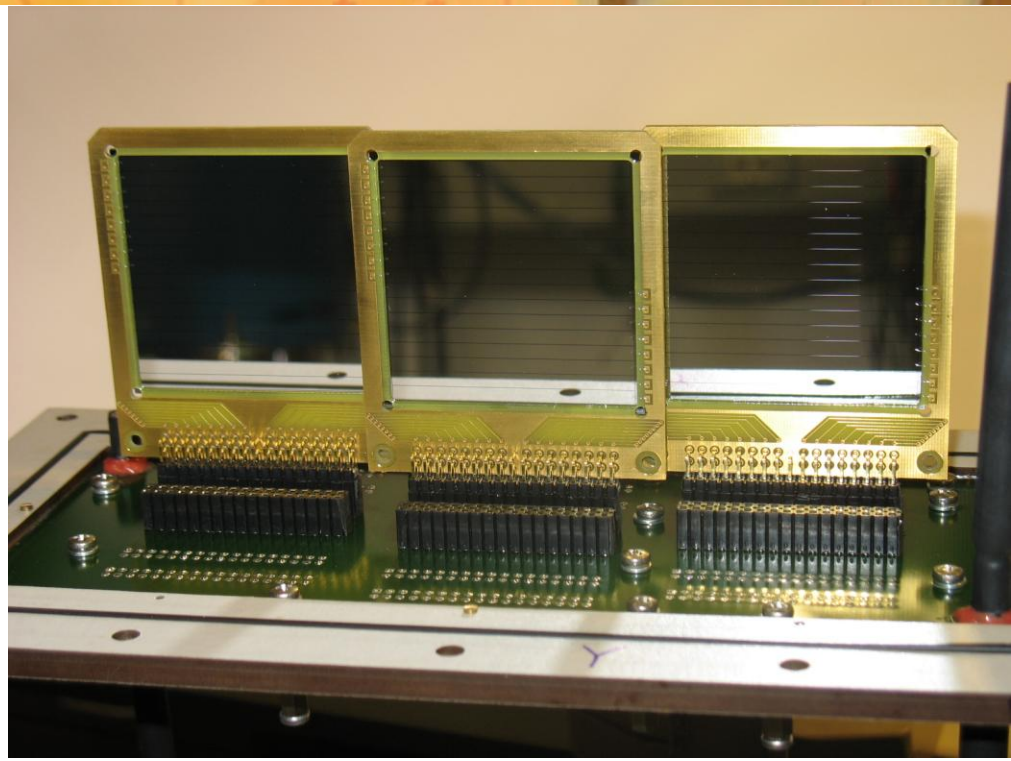


Stopped Beams - Active Stopper

implantation-particle decay correlation

3-6-9 DSSSDs

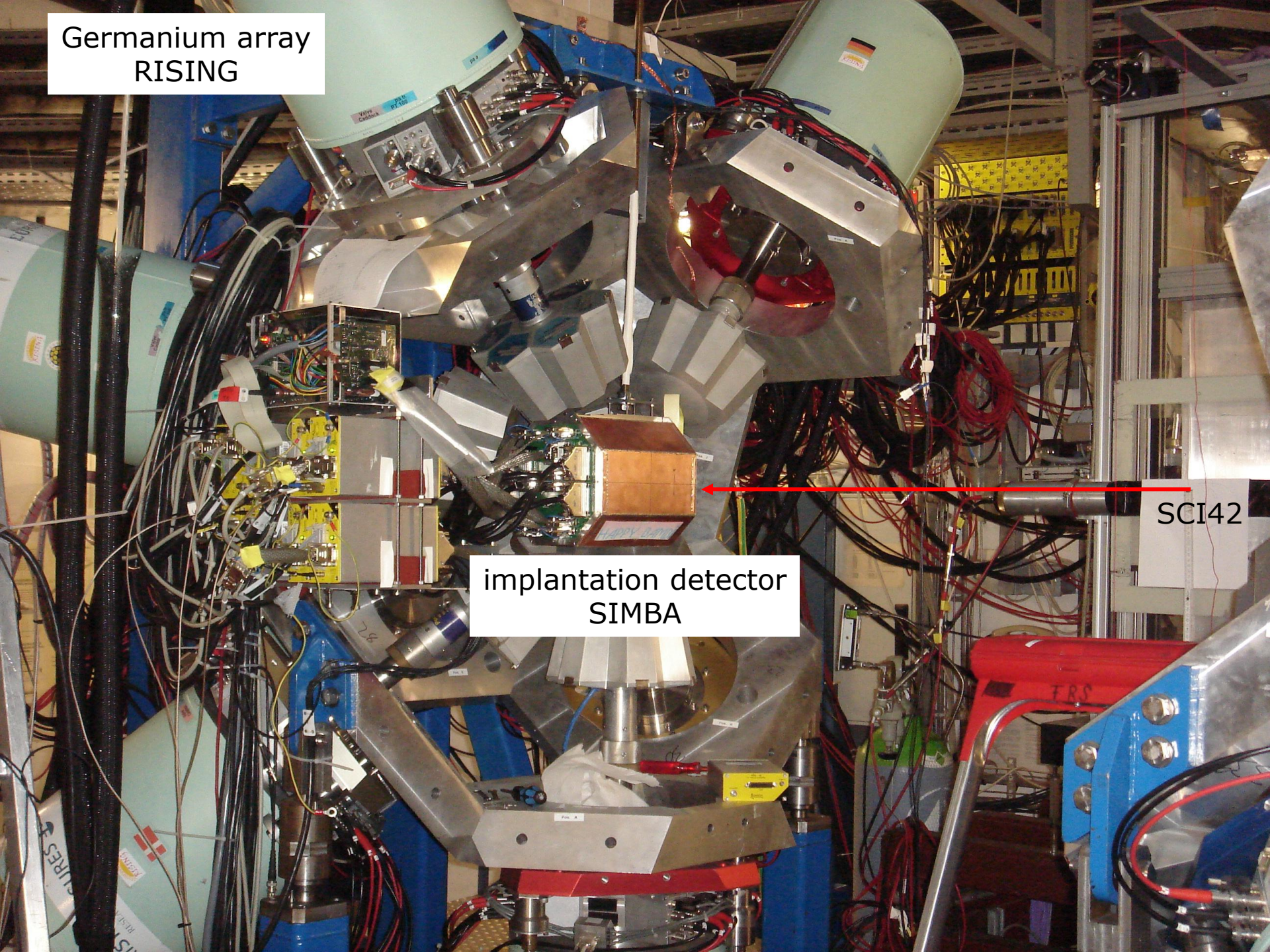
- surface 5x5 cm^2
- thickness 1 mm
- 2 x 16 3.125 mm strips



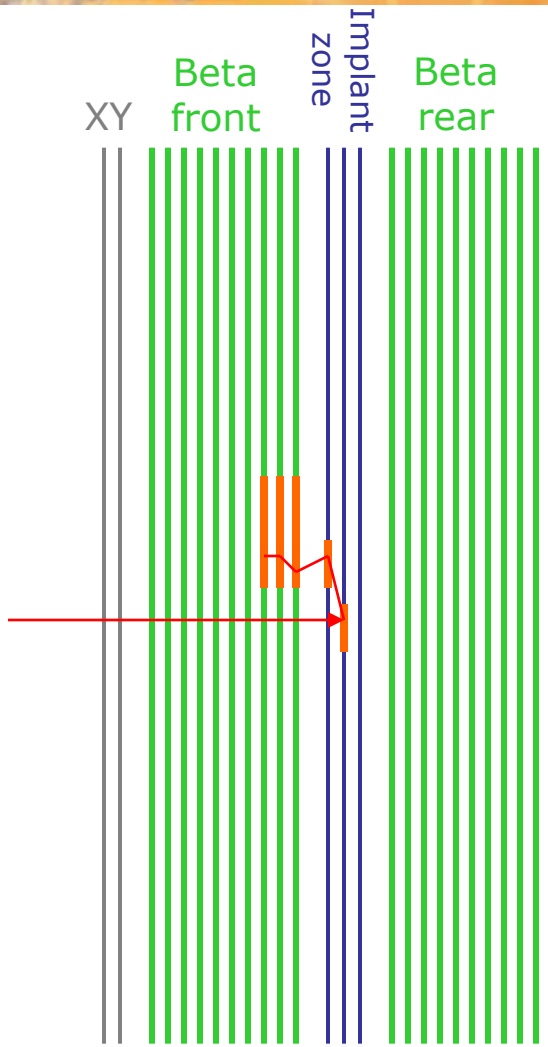
$T_{1/2}$ ms to min.

associated with delayed γ-rays

Passive Stopper: γ-ray from isomer cascades with $T_{1/2}$ ~ 10 ns → 1 ms.


Germanium array
RISING
SCI42
implantation detector
SIMBA

Implantation detector SIMBA (TU Munich)



Implantation zone
Calorimeter for decay particles

Measurement of time and spatial correlation between implantation and decay
Measurement of positron energy
Measurement of energy of emitted protons or α-particles
Measurement of energy of emitted γ rays' conversion electron

The implantation detector consists of

23 silicon detectors in total

XY position: 2 SSSD, 60 strips, 60x60x0.3mm^3

beta absorbers front: **10 SSSD**, 7 x-strips, 60x40x1.0mm^3

implantation zone: **3 DSSD**, 60 x 40 strips, 60x40x0.7mm^3

beta absorbers rear: **10 SSSD**, 7 x-strips, 60x40x1.0mm^3

RISING: Stopped beams

Convenor: P. Regan, University of Surrey

P. H. Regan

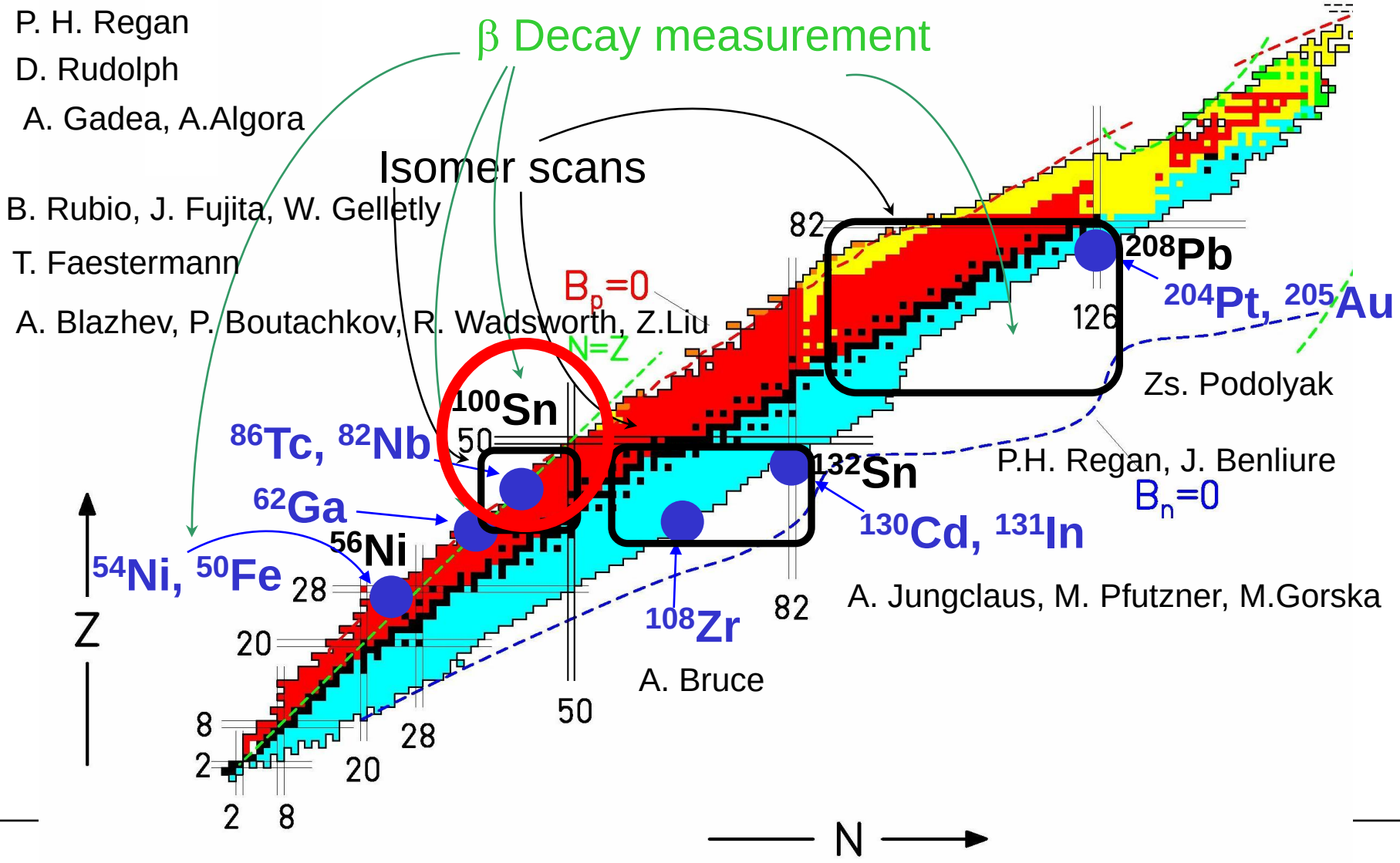
D. Rudolph

A. Gadea, A.Algora

B. Rubio, J. Fujita, W. Gelletly

T. Faestermann

A. Blazhev, P. Boutachkov, R. Wadsworth, Z.Liu



Isomer scans

A. Jungclaus, M. Pfutzner, M.Gorska

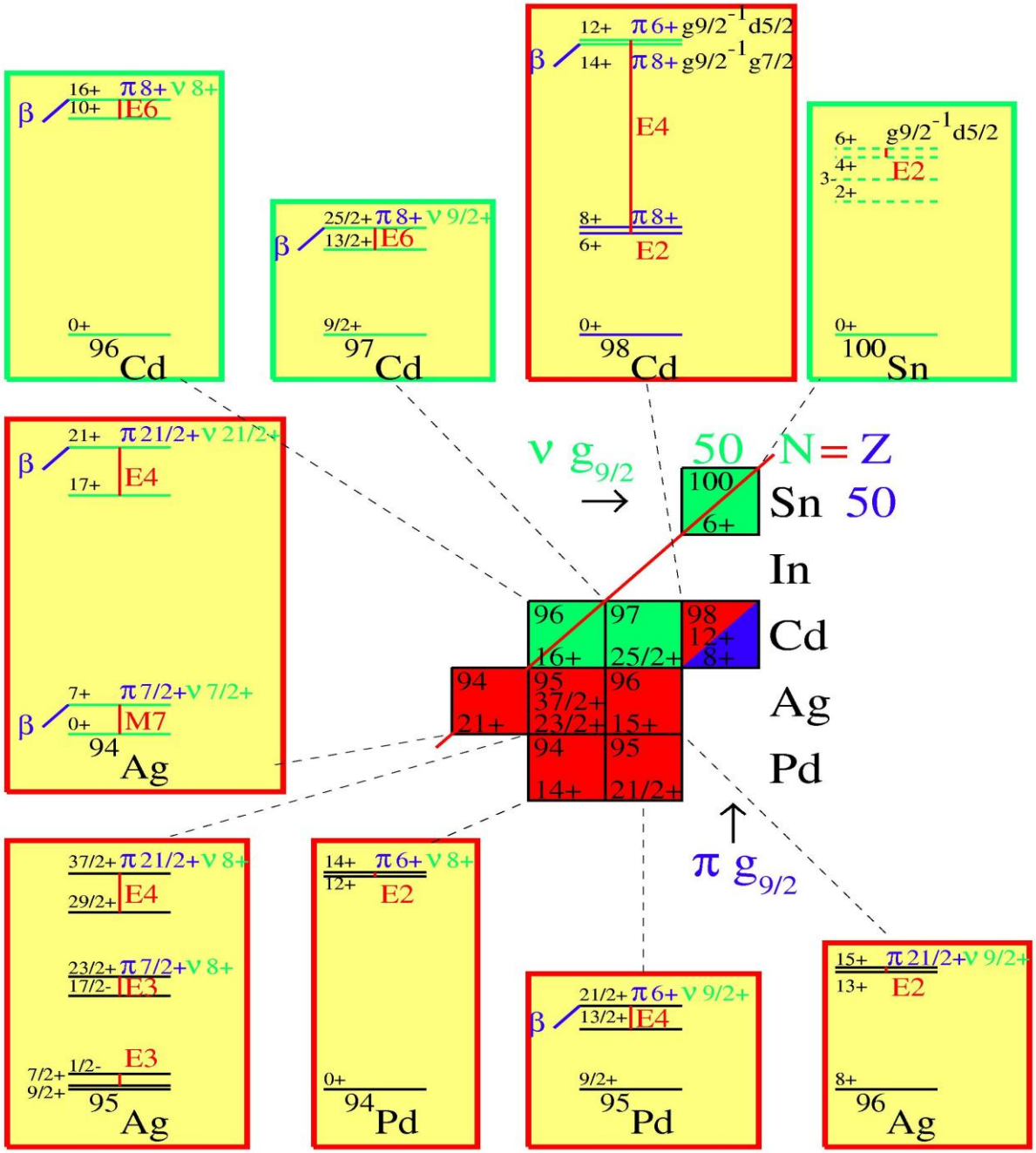
β Decay measurement

A. Bruce

Zs. Podolyak

P.H. Regan, J. Benliure

Spin gap isomers below N=Z=50



Expected

Known

Paestum 2003

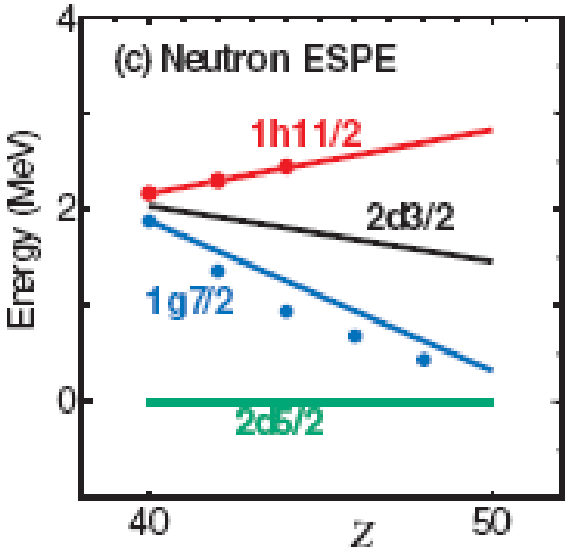
GSI

^{100}Sn region

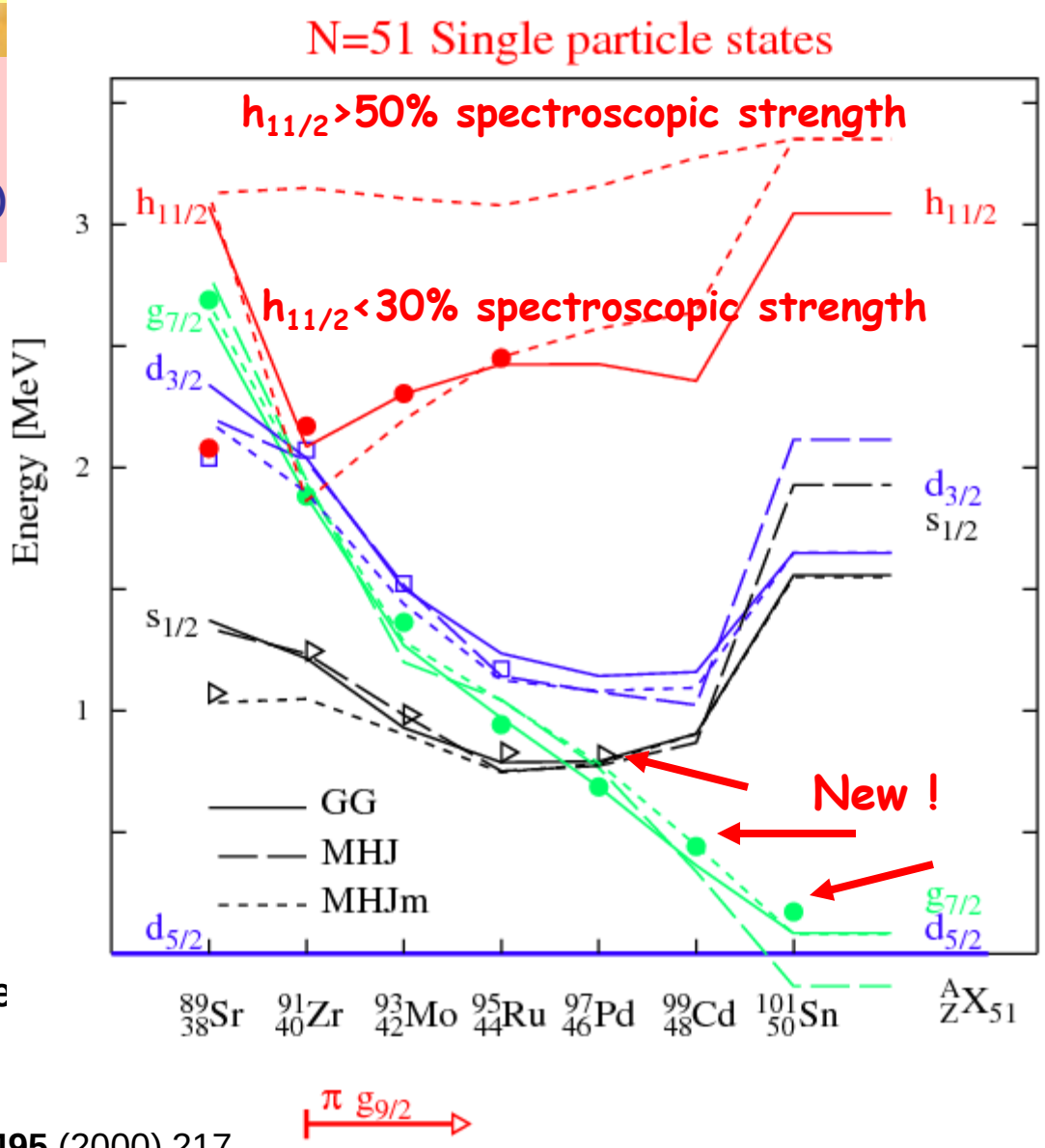
Tensor interaction monopole

$\nu h_{11/2} - \pi g_{9/2}$, $\nu g_{7/2} - \pi g_{9/2}$

T. Otsuka et al., PRL 95, 232502 (2005)

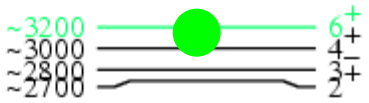


πν interaction tuned for the model space ^{88}Sr, $\pi(p_{1/2},g_{9/2})$ $\nu(d_{5/2}, g_{7/2}, d_{3/2}, s_{1/2}, h_{11/2})$ gives the correct description of the evolution of SPEs



M. Górska et al., Proc. ENPE99, AIP **CP495** (2000) 217

M. Hjorth-Jensen et al., Phys. Rep. 261 (1995) 125 and priv. comm.

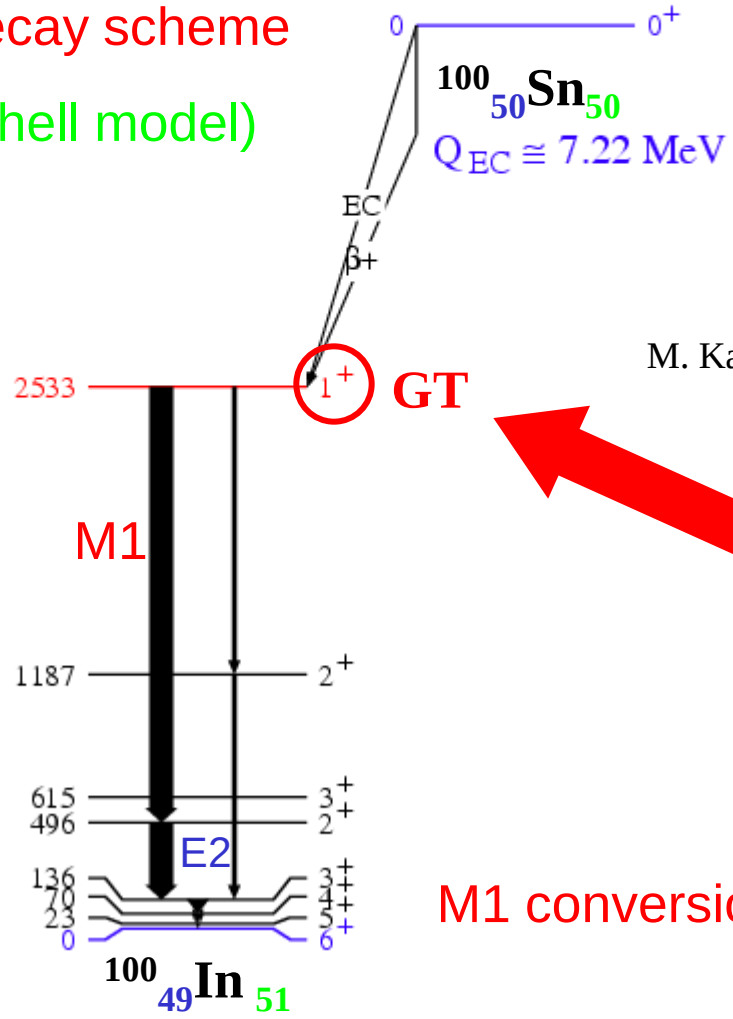


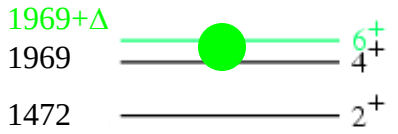
^{100,102}Sn ß$^+$/EC decay

$I^\pi = 6^+$ isomerism

Decay scheme

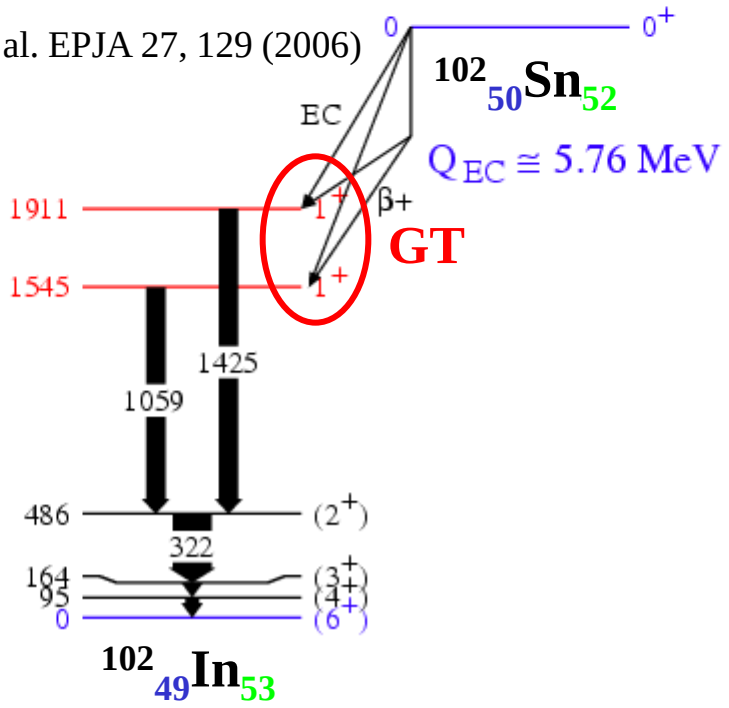
(shell model)





Decay scheme

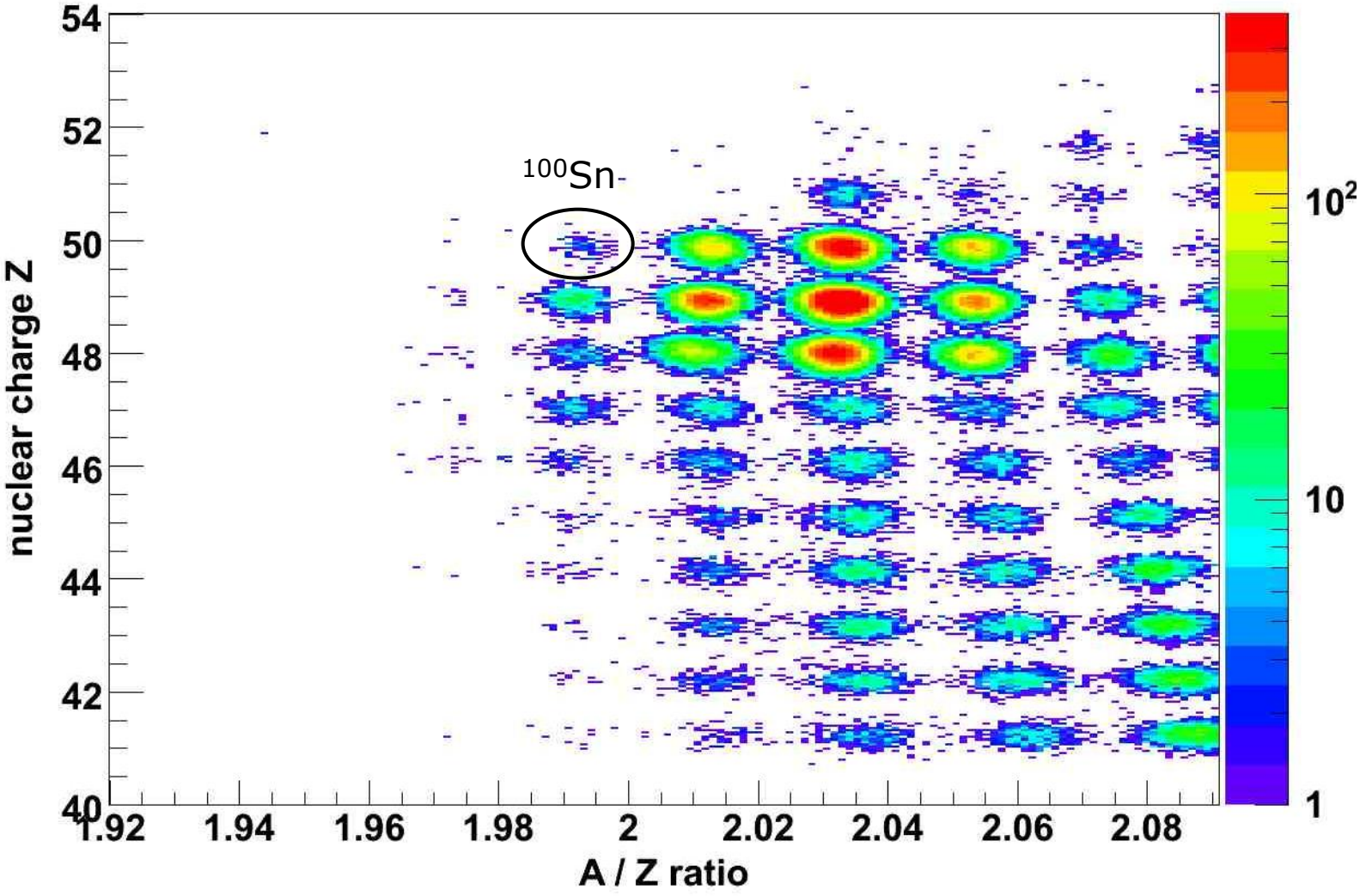
M. Karny et al. EPJA 27, 129 (2006)



M1 conversion

Particle identification spectrum

March 2008 T.Faestermann et al.

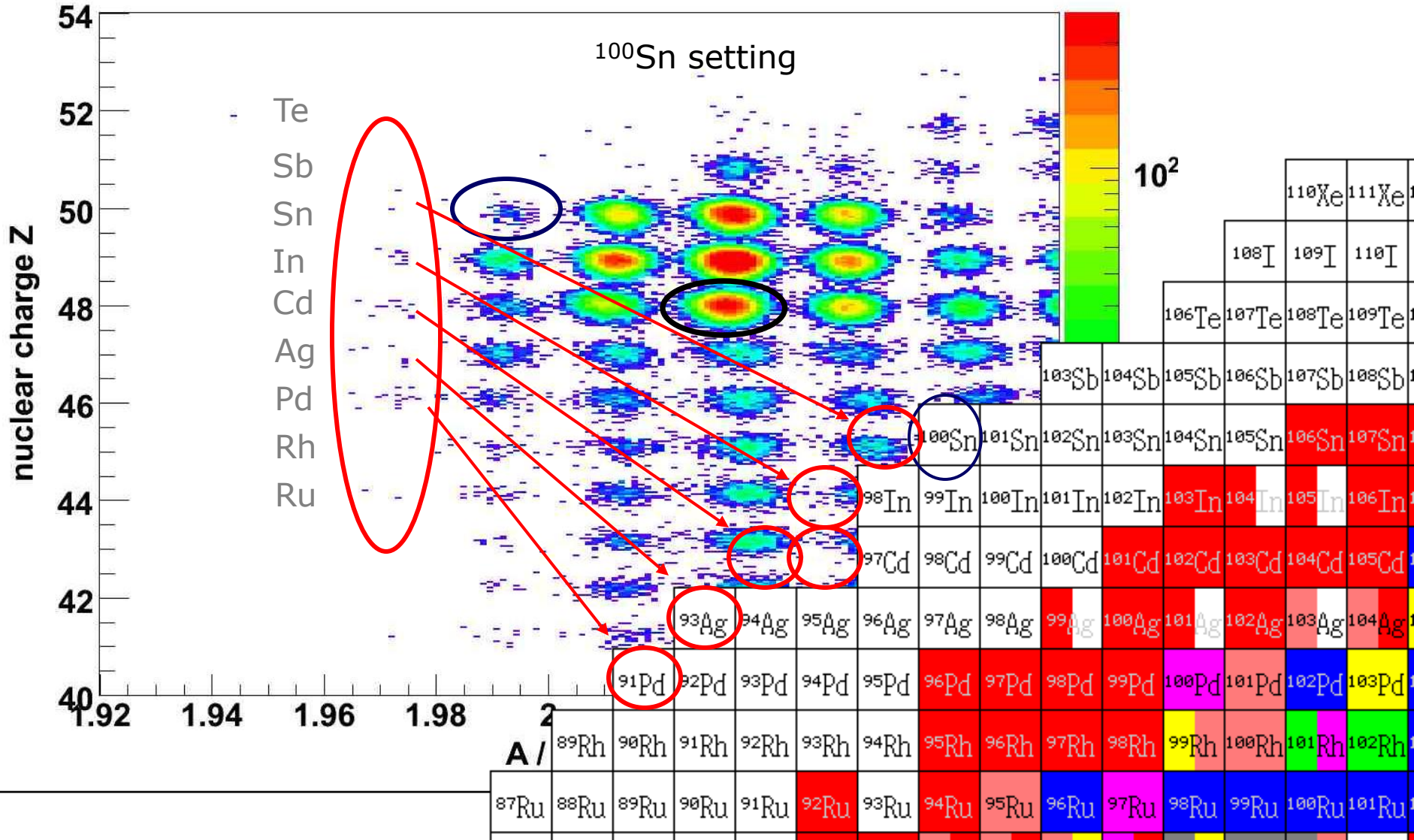


Probing proton dripline

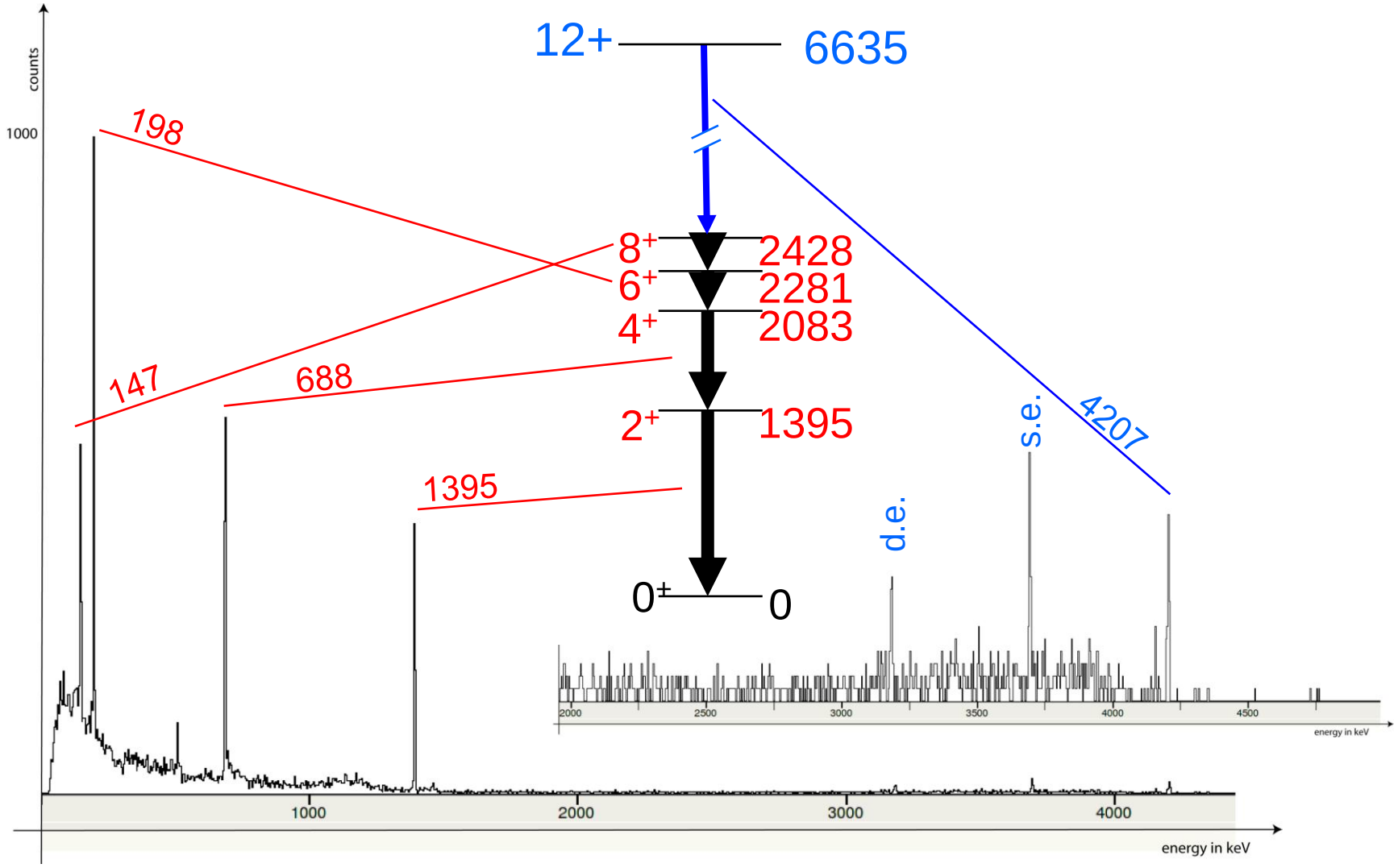
T.Faestermann

analysis: K.Eppinger, C.Hinke

TU München

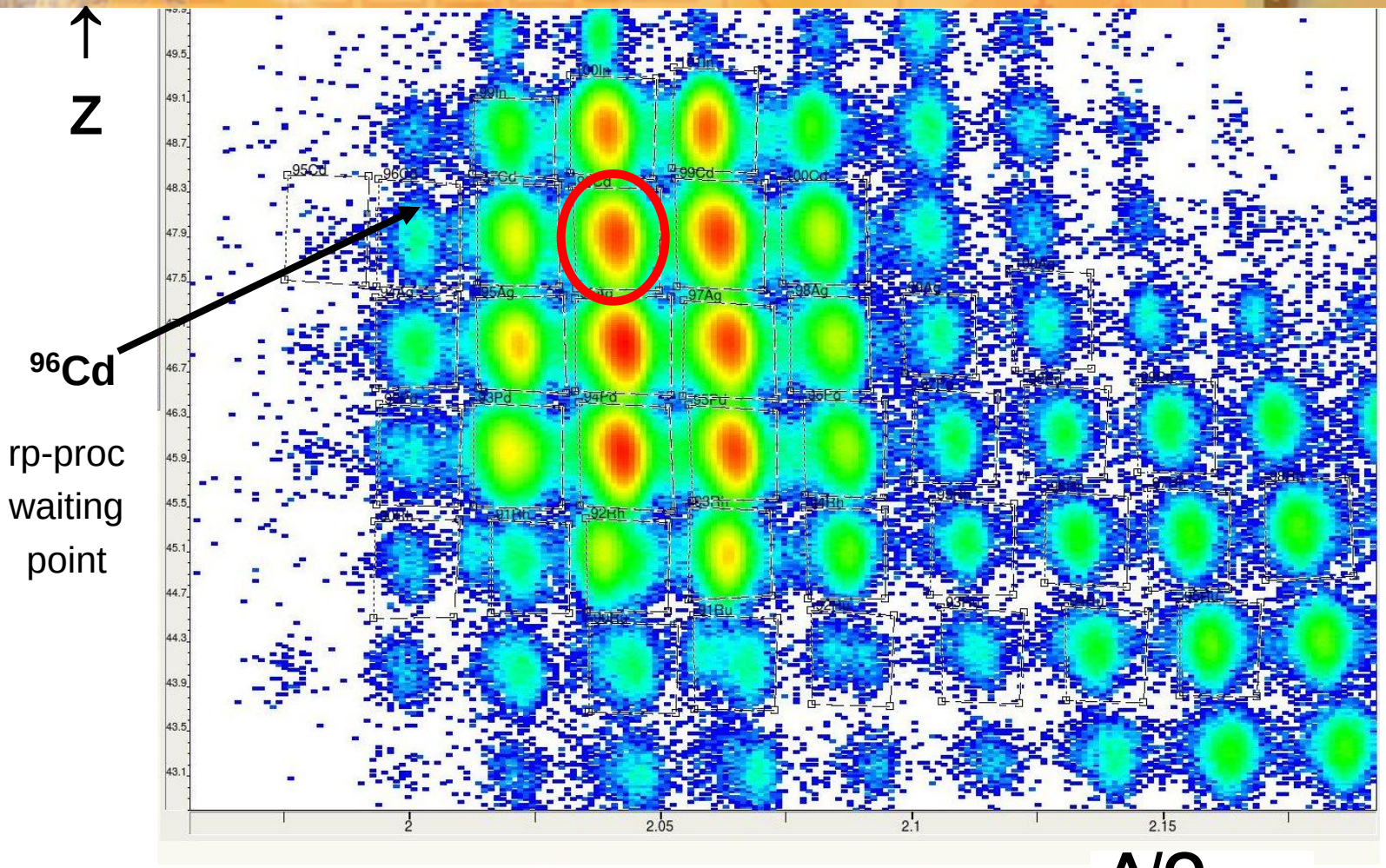


^{100}Sn setting check : ^{98}Cd



96-98Cd: July 2008

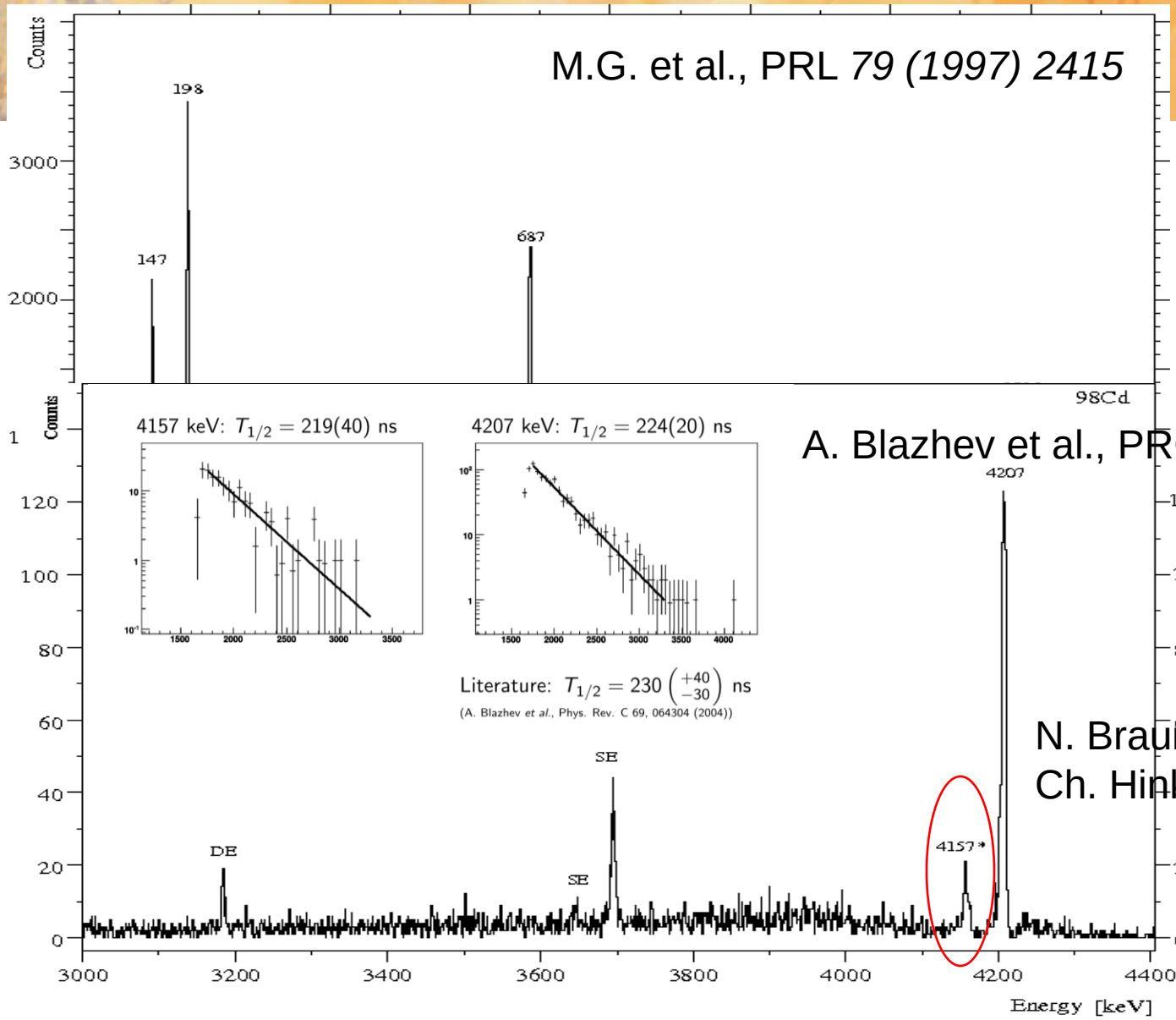
B. Wadsworth et al.,



Prelim estimate > 2000 ^{96}Cd ions

^{98}Cd revised!

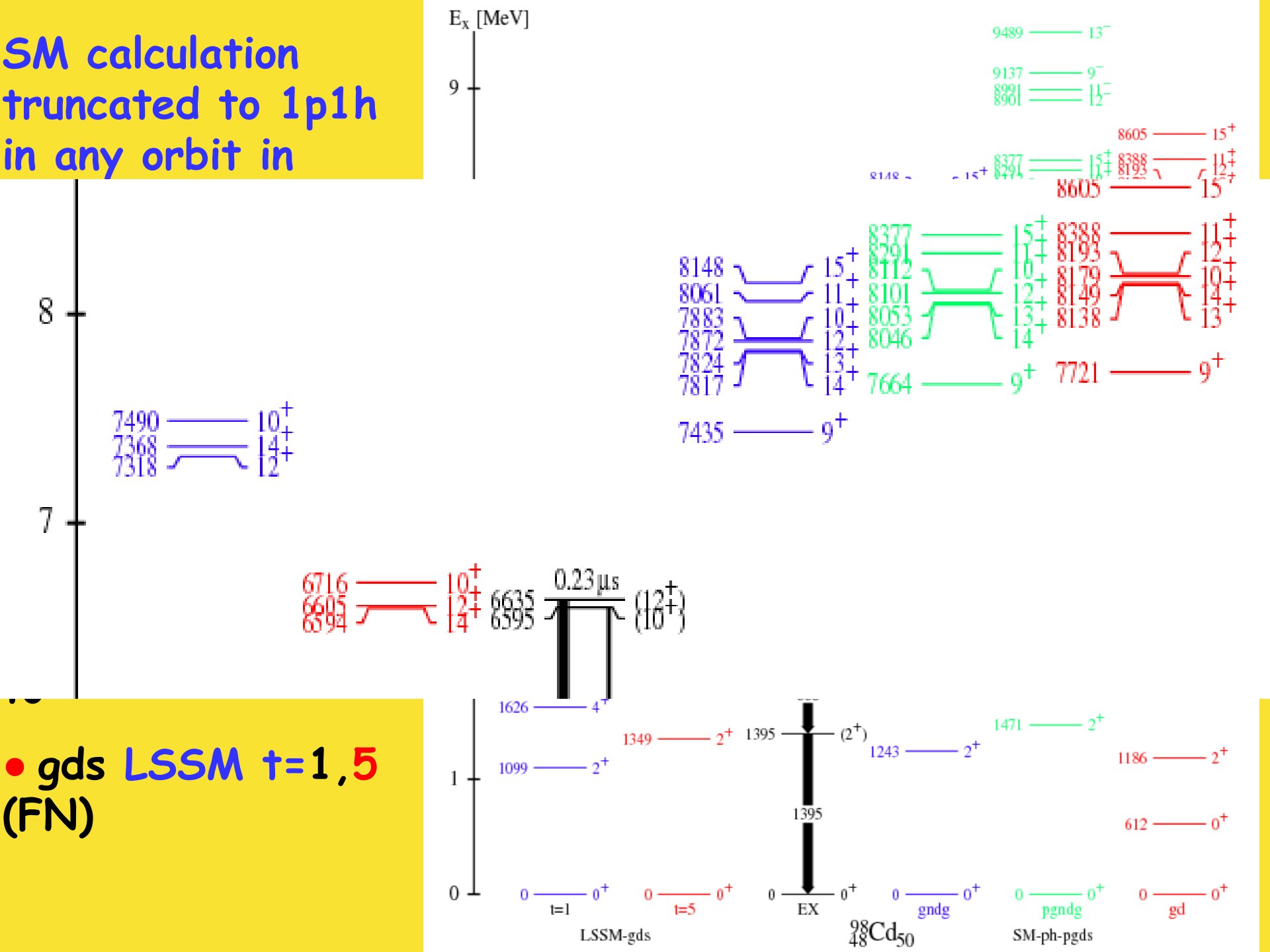
M.G. et al., PRL *79 (1997) 2415*



A. Blazhev et al., PRC 69, 064304 (2004)

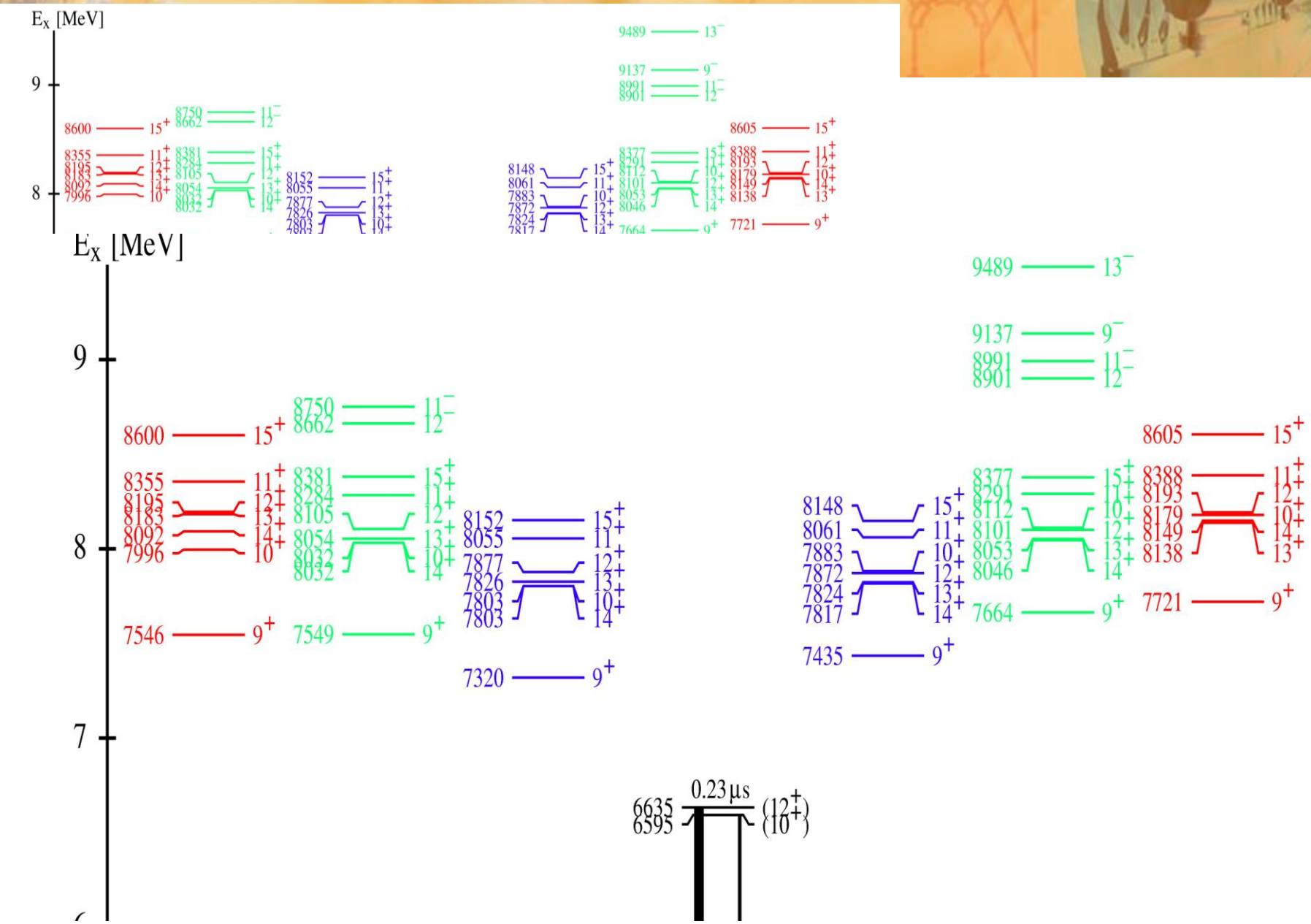
N. Braun, U. Cologne
Ch. Hinke, TUM

SM calculation truncated to 1p1h in any orbit in



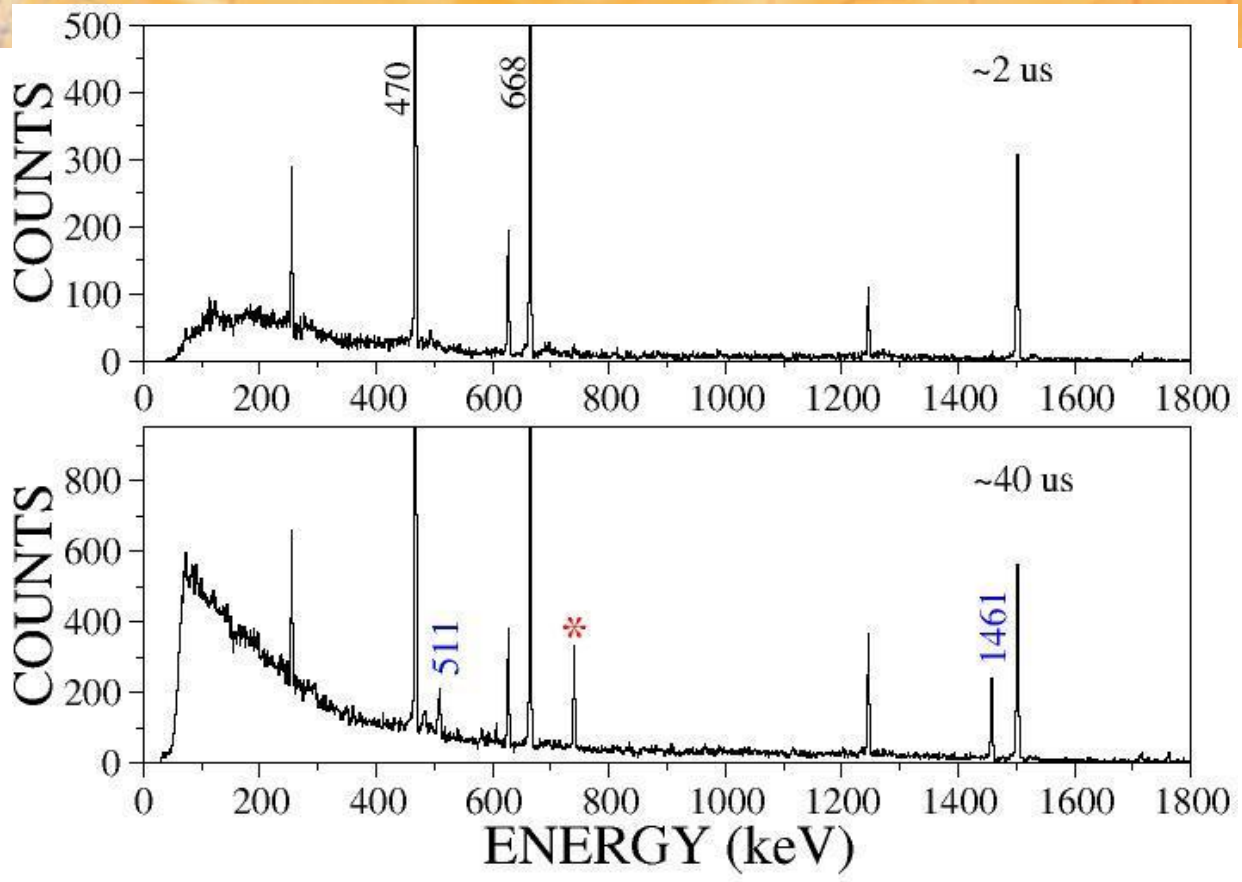
- gds LSSM t=1,5 (FN)

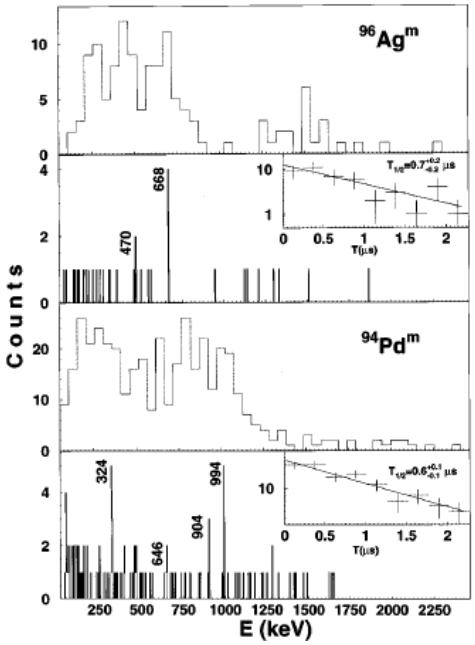
Indication of the ground state spin in ^{101}Sn?



Experiment – July 2008: Other isomers: ^{96}Ag

P. Boutachkov et al., to be published





R Grzywacz et al., PRC 55, 1126 (1997)

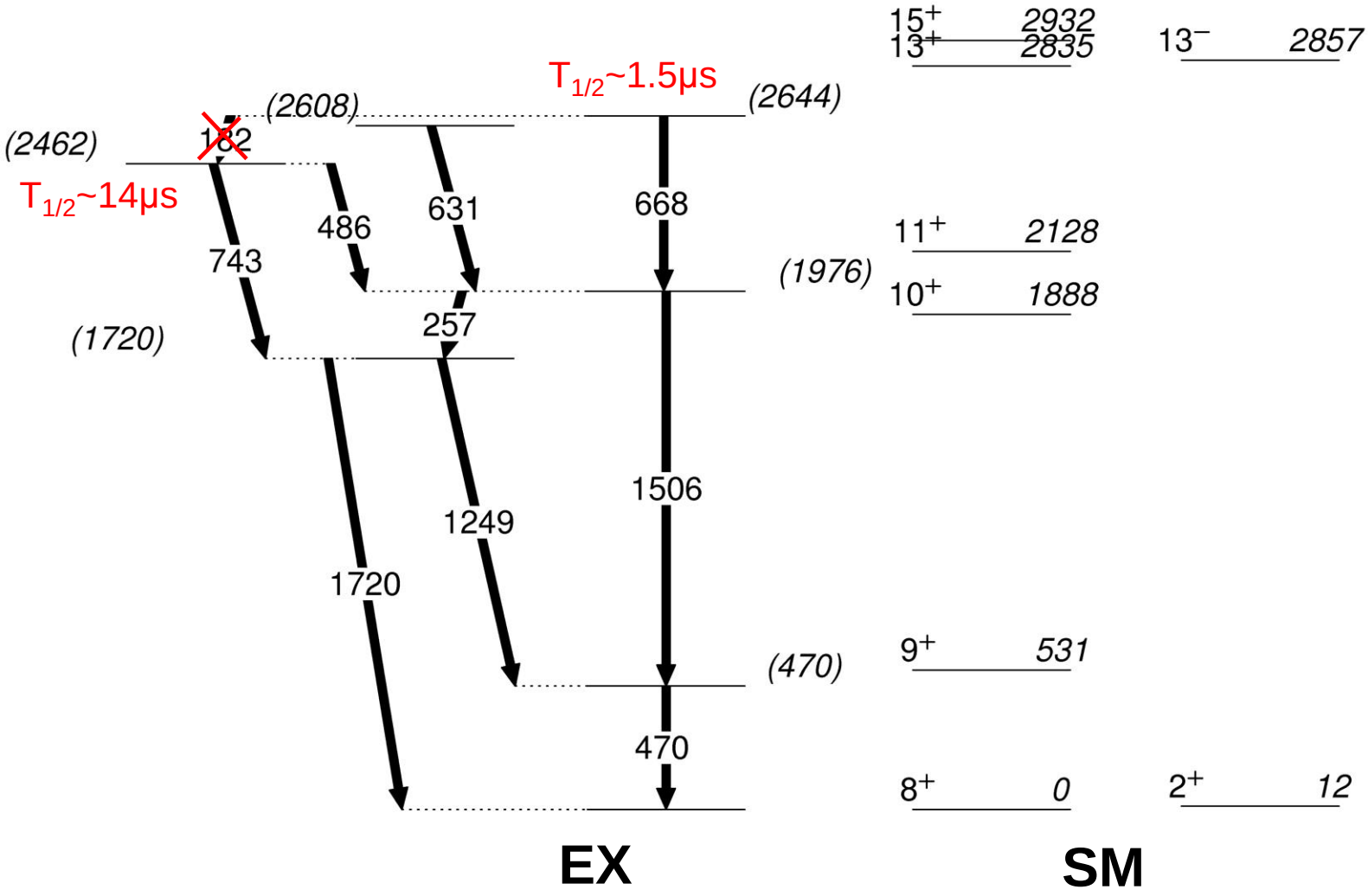
GF int. + πν(g9/2,p1/2) model space

→ 13^{-}, 15^{+} isomers

R. Gross and A. Frenkel, Nucl. Phys. A 267, 85 (1976)

^{96}Ag Level scheme

P. Boutachkov et al, last week



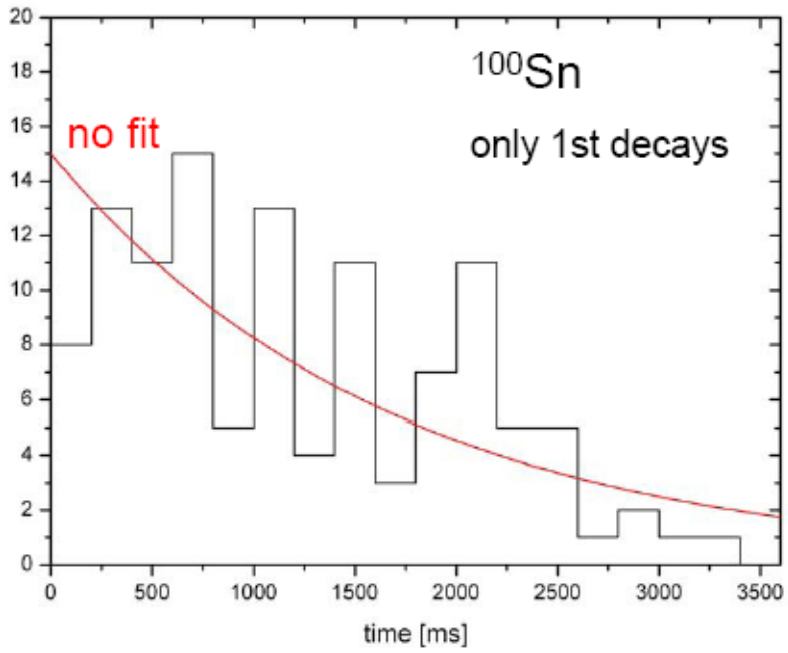
Correlation of Implantation and Decay

T. Faesterman et al., to be published

require same position within ± 1mm in x,y,z

record all decay triggers within 15 s
(β^+ of 3 generations)

Maximum Likelyhood analysis
varying the ^{100}Sn half-life
with known: daughter decays,
efficiencies, dead times, background



$T_{1/2}$ = 1.16 ± 0.20 s

preliminary

Comparison:

MSU 2007 $0.55^{+0.70}_{-0.31}$ s

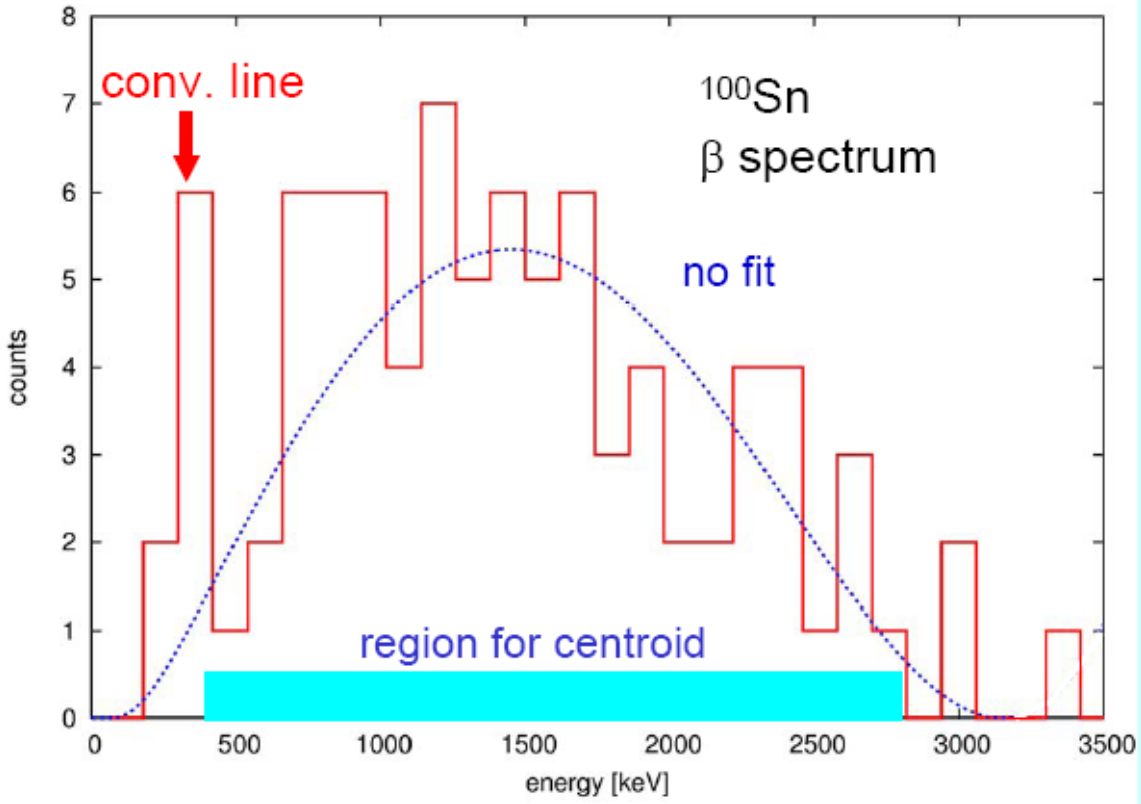
GSI 1997 $0.94^{+0.54}_{-0.26}$ s

Extraction of Beta Spectrum

T. Faesterman et al., to be published

Sum over total energy within 3 s after implantation

in implantation zone + calorimeter



from centroid

E_{max} = 3.15 ± 0.20 MeV

Q_{EC} = 4.17 ± 0.20 MeV

to excited state

preliminary

=> I_β = 85%

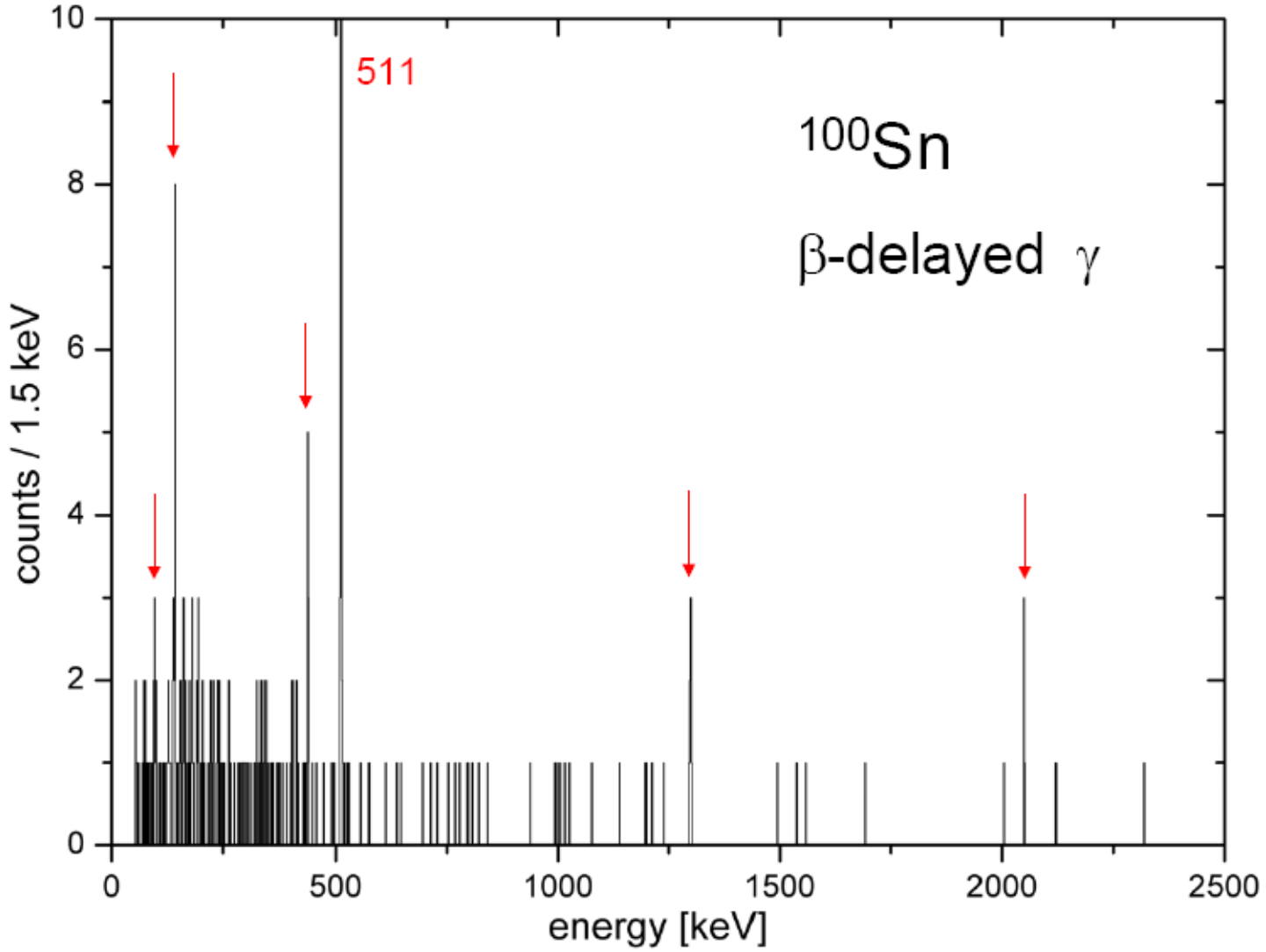
log ft = 2.54 ± 0.20

that's record

Gamma Spectrum after Beta Decay of ^{100}Sn

T. Faesterman et al., to be published

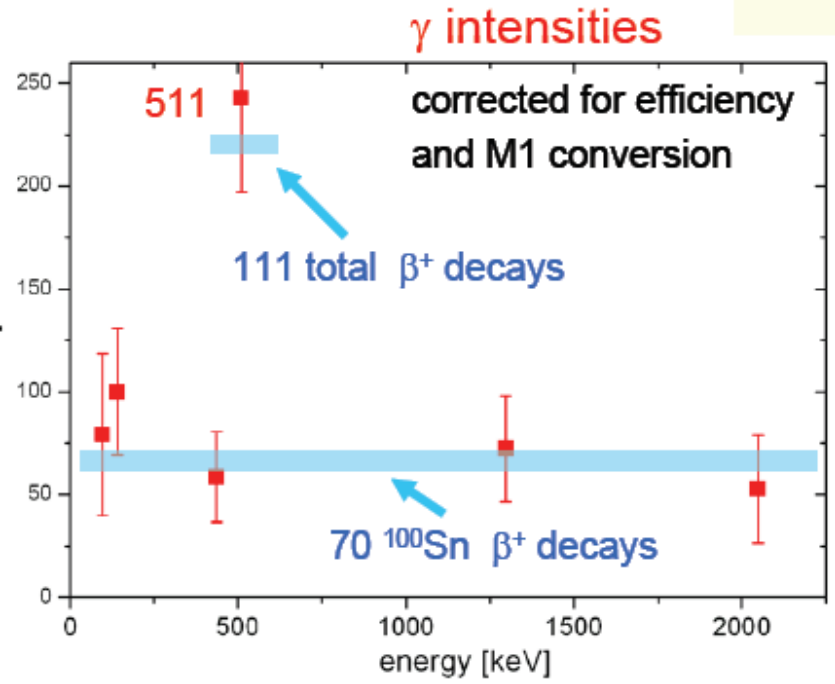
all events within 4 s after implantation

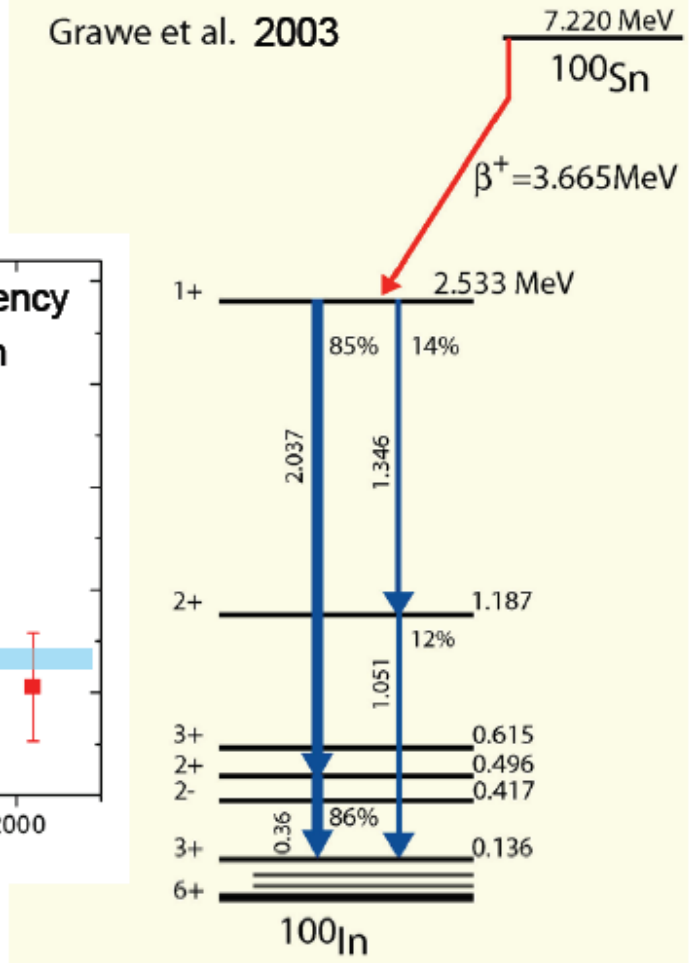


Gamma Intensities

T. Faesterman et al., to be published

what do we expect?





5 lines add up to
4018 keV ???

Gamov Teller Strength

T. Faesterman et al., to be published

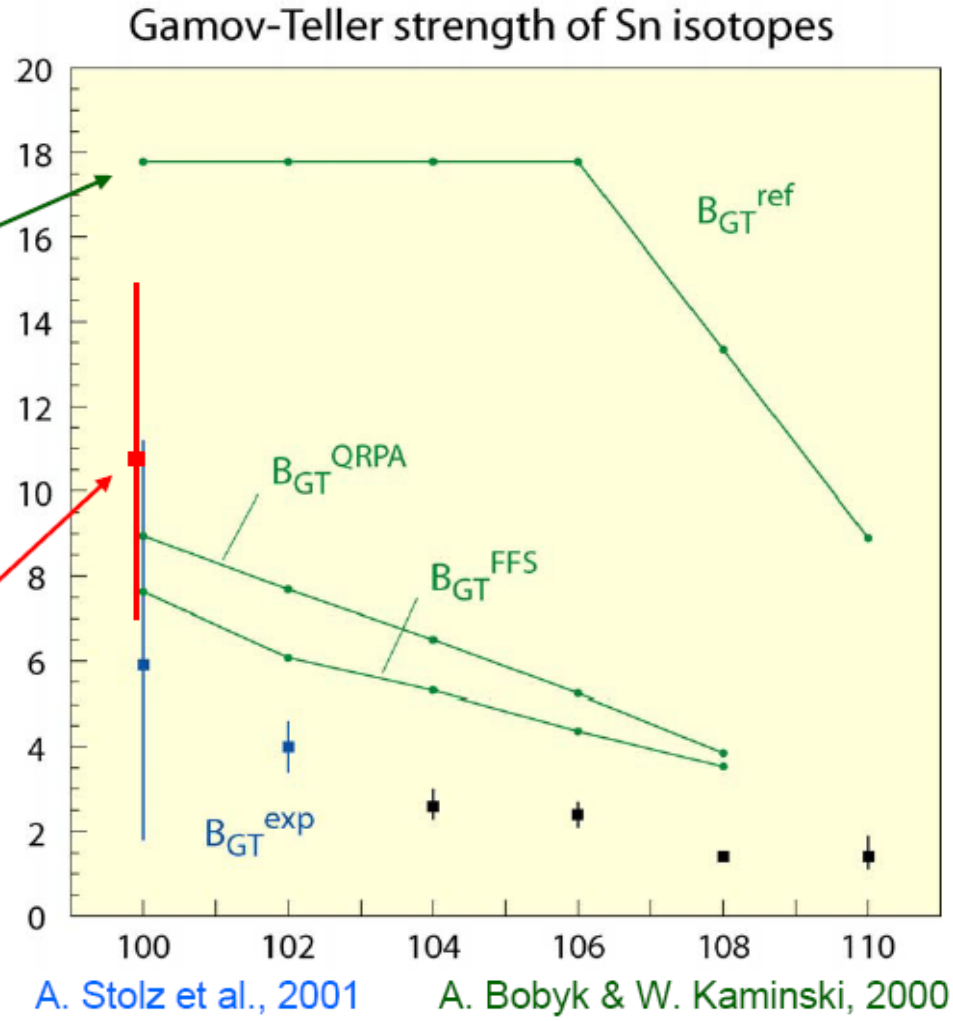
still very preliminary

$$B_{GT}^{ref} = \frac{4l}{2l+1} \cdot N_{\pi g9/2} \cdot \left(1 - \frac{N_{\nu g7/2}}{8}\right)$$

$$B_{GT}^{ref} = 17.8$$

$$B_{GT}^{exp} = \frac{2Ft}{\left(g_A / g_V\right)^2 ft} = \frac{6142.8s}{1.2695^2 \cdot ft}$$

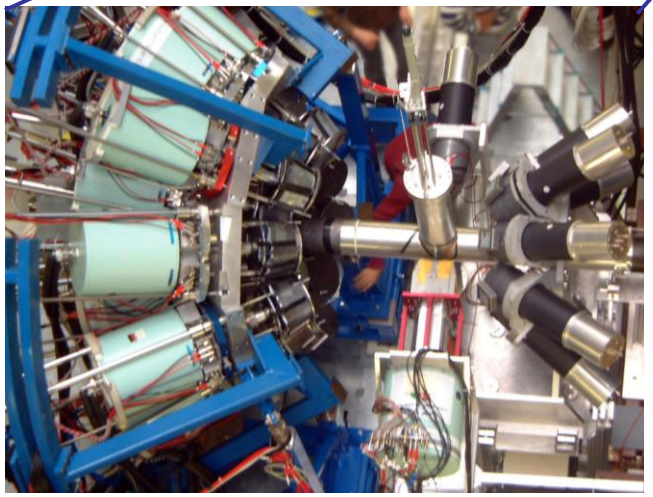
$$B_{GT}^{exp} = 10.9 \pm 4.1$$



RISING summary

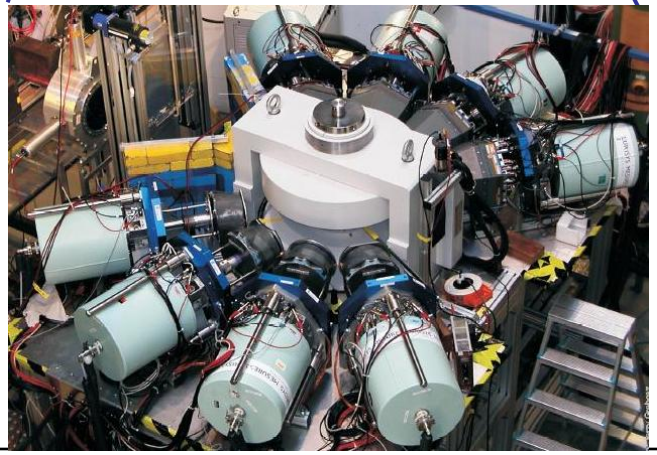
2000 2002 2004 2006 2008 2010

RISING
Fast beam campaign

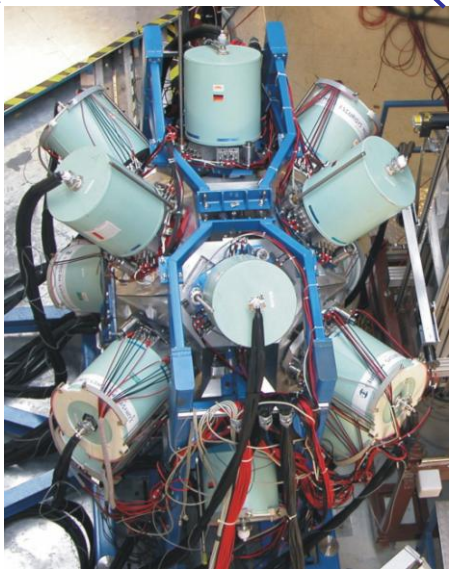


g-RISING

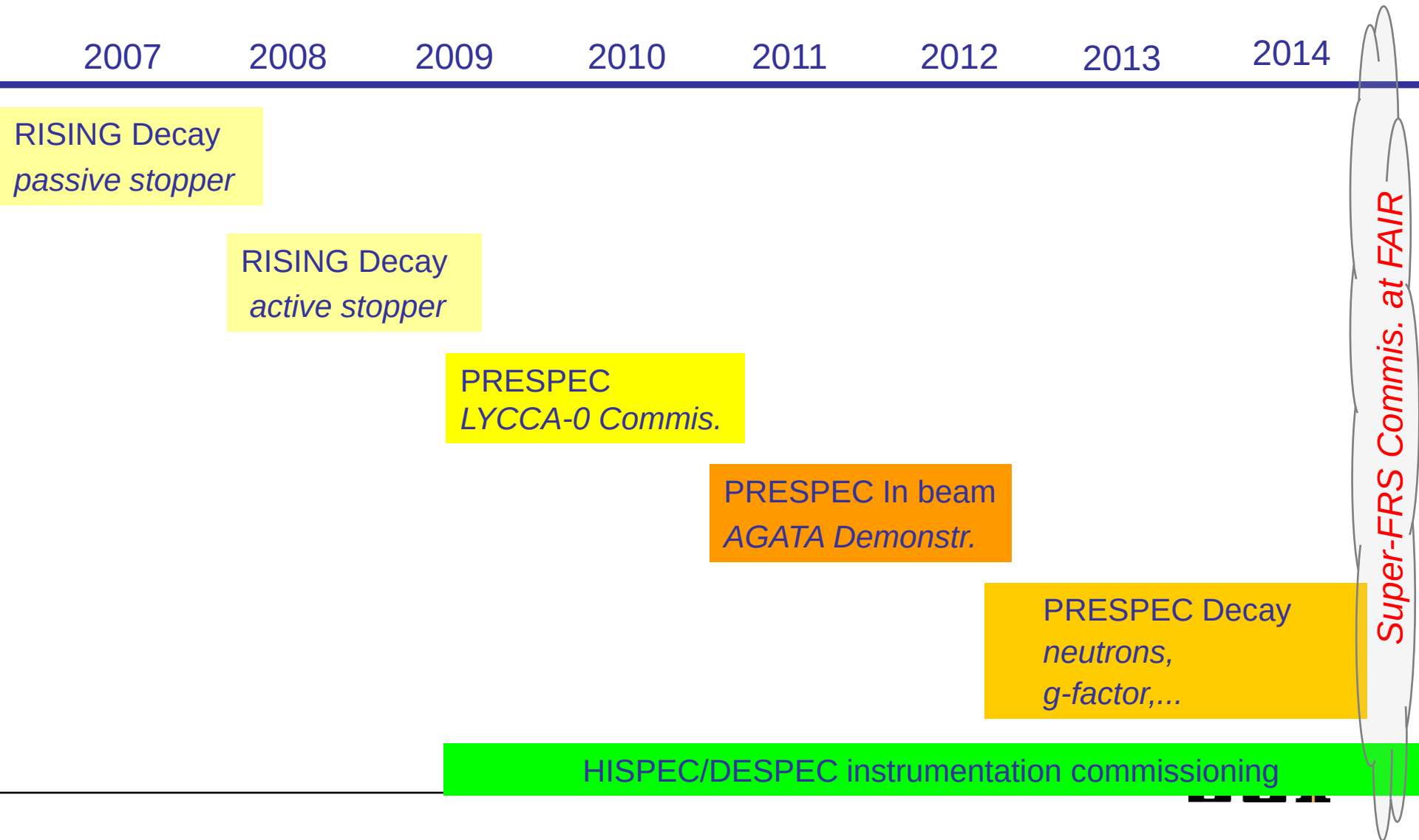
(Leuven Group)



RISING
Stopped beam campaign



RISING to PRESPEC to HISPEC/DESPEC

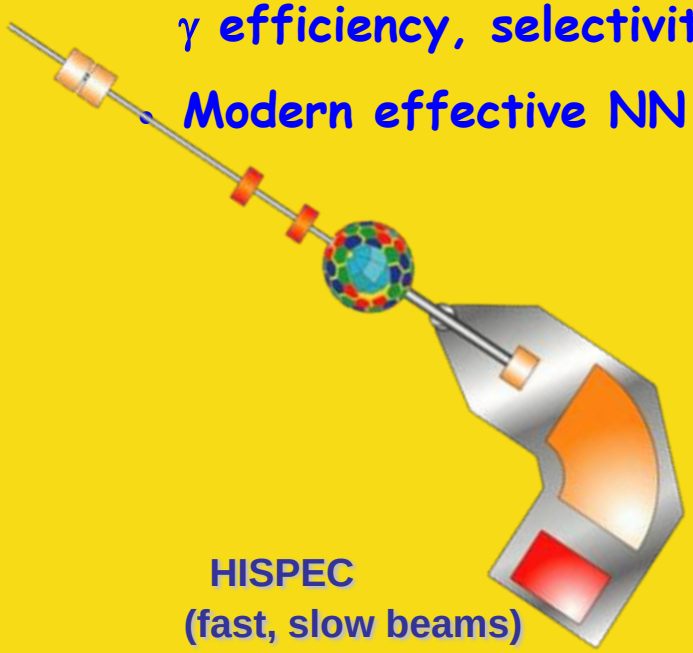


Conclusion:

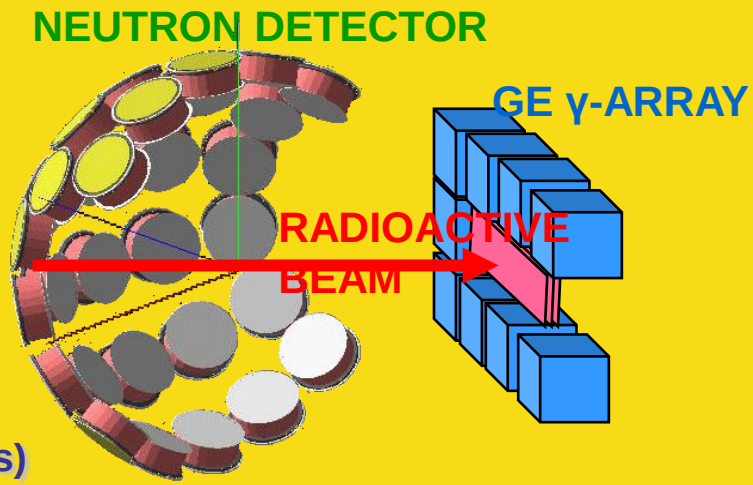
- Fragmentation + fission of relativistic beams + FRS + RISING
- Precision spectroscopy of exotic nuclei → tuning of effective NN interaction
- Monopoles determine shell evolution
- Nuclear structure and astrophysics

Future :

- FAIR + Super-FRS + HISPEC/DESPEC → intensity, acceptance, γ efficiency, selectivity
- Modern effective NN interactions, SM techniques



HISPEC
(fast, slow beams)



DESPEC
(stopped beams)

Collaboration:

A. Blazhev2, P. Boutachkov1, T. Brock3, N. Braun2, L. Caceres1, K. Eppinger4,
T. Faestermann4, J. Gerl1, H. Grawe1, Ch. Hinke4, M. Hjorth-Jensen5
A. Jungclaus6, Z. Liu7, G. Martínez-Pinedo1, B.S. Nara Singh3, R. Krücken4,
F. Nowacki8, S. Pietri1, M. Pfützner9, Zs. Podolyak10, P.H. Regan10,
D. Rudolph11, K. Sieja1, R. Wadsworth3, H.J. Wollersheim1
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